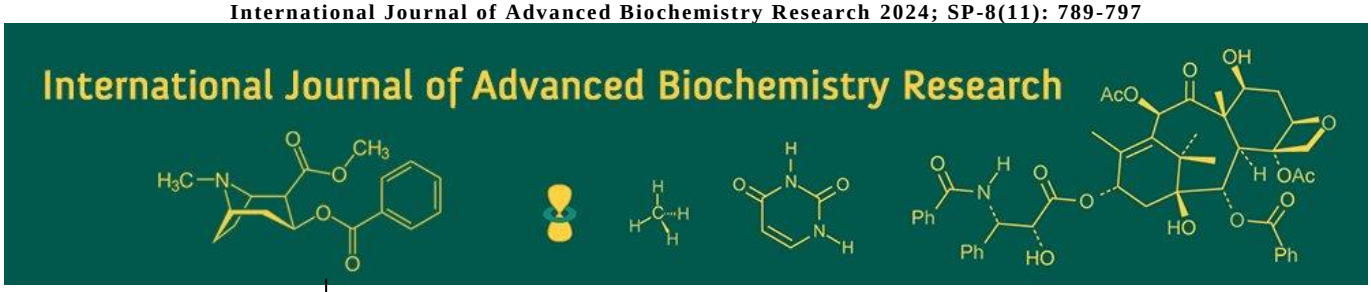

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Radiological evaluation of potential thoracic foreign bodies and its surgical management in cattle

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Abstract
Background: Potential thoracic foreign body can migrate to right and left hemithorax in cattle depending on its direction of penetration. No literature is available to detect exact location of potential foreign body in thoracic cavity using radiology in India. The present investigation was carried out to pinpoint the exact location of foreign body in thoracic cavity is very essential for successful outcome of thoracotomy in cattle
Methods: The present study was carried out in 12 clinical cases of various breeds of cattle presented to Veterinary Clinical Complex, College of Veterinary and Animal Sciences Udgir with history of jugular pulsation, progressive detoriation of body condition, brisket edema, loss of rumination and tachycardia were evaluated for traumatic reticular foreign bodies. All animals were subjected for lateral (right or left) thoraco abdominal radiographic evaluation and appropriate thoracotomy procedure was planned under isoflurane inhalation anaesthesia.
Results: Non-descript (61.11%) breeds of the cattle showed highest incidence of thoracic foreign bodies particularly in female and lactating animals in present study. Clinically, all animals exhibited anorexia, jugular pulsation, brisket edema and emaciation. Radiographic examination revealed sand filled reticular folds, glassy or cloudy appearance on radiographs (adhesions), lung consolidation, loss of cardiac silhouette and diaphragmatic contour. During the radiography, Source-Image-Distance (SID) and magnification concept was kept in the mind i.e., the object is brought nearer to source, the shadow enlarges and vice and versa. In present study 5 animals showed presence of thoracic foreign bodies in right hemithorax, followed by 4 animals in central hemithorax and 3 cases exhibited left hemithorax foreign bodies on basis on length of foreign bodies measured via computerized radiography and removed via complete rib resection technique. To conclude, radiographic evaluation of thoracic foreign bodies, SID and magnification concept revealed shorter the distance between object and light source, the magnification of image (foreign body) supposed to be greater which helps in detecting exact location of foreign bodies in the hemithorax right or left.

Keywords: Adhesion, brisket edema, cattle, magnification, radiography, thoracotomy

Introduction
As per 20th livestock census, cattle population in India is 192.49 million which is second highest in world. Cow considered as sacred animal. Cattle required balanced nutrition for optimum production, but in Marathwada region cattle mainly maintained on dry roughages, these are nutritionally deficient. A bizarre disease of wicked hunger called pica in which animal starts eating object which usually they would not (Akgul *et al.*, 2000) [2]. Young, lactating and pregnant animas mainly susceptible to develop this condition (Firyal, 2007) [11]. Cattle are non-selective feeders and they do not utilize their lips for prehension hence they are more prone to ingest of foreign body than small ruminant (Tesfaye and Chanie, 2012) [26]. Ruminant stomach generally made of four chambers among this reticulum is more frequently involved in implantation of foreign bodies, because of honeycomb like structure (Roth and king 1991) [22].
Ingested sharp foreign body perforates reticulum causing release of ingesta into abdominal cavity which cause peritonitis and adhesion formation with reduced reticular motility. Traumatic pericarditis, vagal indigestion, pyothorax, liver and spleen abscesses, diaphragmatic hernia, traumatic pneumonia and pleurisy are possible sequels to penetrating sharp foreign bodies (Anteneh and Ramaswamy, 2015) [3].

Anatomically pericardium and reticulum very closely situated due to reticular contraction potential foreign body can easily enter into the thoracic cavity causing traumatic pericarditis (Athar *et al*., 2012) [6]. This condition is very common in pregnant and recently parturiated animals because pressure of foetus and uterine contraction contribute to perforation of reticulum by potential foreign body (Ghanem, 2010) [12]. Clinical signs noticed in traumatic pericarditis are tachycardia, muffled heart sound, jugular distension, brisket edema, not every affected animal necessarily shows these pathognomonic signs. For confirmatory diagnosis plain or contrast radiograph is essential. Potential foreign bodies better visualize in right lateral recumbency than standing (Makhdoomi *et al*., 2018) [18]. Maximum animals show uneventful recovery and life span prolonged after removal of foreign body from thoracic cavity by thoracotomy (Bakos and Voros., 2011 and Domingues *et al*., 2020) [7, 10] in standing sedation and using general anaesthesia. Potential foreign body can migrate to right and left hemithorax depending on its direction of penetration. Exact location of foreign body in thoracic cavity is very essential for successful outcome of thoracotomy. No literature available to detect exact location of potential foreign body in either right or left hemithorax using radiology. Present study conducted to exact location of foreign body on 31 animals having thoraco abdominal foreign body, its clinical haematological alterations and surgical management.

Materials and Methods

Total 243 clinical cases of cattle were reported to Veterinary Clinical Complex, College of Veterinary and Animal Sciences, Udgir during the period of January 2022 to January 2023 with history of various thoracoabdominal disorders and they examined thoroughly via survey radiography. Out of 243, 31 animals showed thoracoabdominal foreign bodies in which 18 thoracic and 13 reticular foreign body detected. All these animals shown chief complain of chronic anorexia, brisket oedema, progressive detoriation of body conditions, jugular pulsation, tachycardia and non-responsive to medicinal treatment. Present study conducted on 12 clinical cases of cattle suffering with thoracic foreign body. Animals screened for physiological parameters like heart rate, respiratory rate, colour of mucous membrane and rectal temperature. Animals showing signs of foreign body syndrome subjected to radiological examination in right as well as left lateral recumbency to locate foreign body in thoracic cavity.

Blood sample collected to haematological studies during pre-surgical, during surgery and postsurgical (after 48 hrs.). These samples were screened for haematological parameters like Hemoglobin (Hb, gm/dl), Packed Cell Volume (PCV%), Total Erythrocyte Count (TEC, 10^6/µl), Total Leucocyte Count (TLC, 10^3/µl), Granulocyte Count (GRA, 10^6/µl) Lymphocyte count (LYM, 10^6/µl) were estimated by using fully automated haematology cell counter. In all 12 animals rumenotomy carried out prior to thoracotomy. Cattle undergone rumenotomy kept off feed for 24 hr. All animals premedicated with Inj. Ceftriaxone @ 10 mg/kg body weight IM, Inj. Chlorpheniramine maleate @1mg/kg body weight, IM and Inj. Meloxicam @ 0.5 mg/kg body weight, IM prior to surgery. All animals sedated with Inj. Diazepam @0.25 mg/kg IV. Endotracheal intubation carried out using induction of anesthesia' in 6 animals out of 12 by using double drip solution of ketamine (@ 50 mg per ml) and (guaifenesin in 5 % dextrose solution of 500 mL) @ 1.5 mL/kg and in remaining animals using propofol @ 3 mg / kg as a single intravenous bolus. All 12 animals were maintained with 2% isoflurane in 100% oxygen. After locating foreign body in thoracic cavity thoracotomy carried out. Location of foreign body was evaluated by preoperative radiographs on the basis of SID and magnification concept. Incision was given directly over targeted rib by incising the skin and thoracic muscle. The longitudinal incision was made on the periosteum is separated from the rib with periosteal elevator of the exposed rib, rib resected with oscillator saw at proximal end and disarticulated from costo-chondral junction. After opening of thoracic cavity foreign body searched and taken out. Statistical data is analyzed by with help of web Agri stat package (WASP, ICAR- CCARI, Goa).

Results and Discussion

Incidence of thoracic foreign body

In present study incidence of thoracic foreign body carried out in cattle. Breed wise incidence for thoracic foreign body were recorded in non-descript (11 out of 18) followed by Deoni (4 out of 18); Red Kandhari (2 out of 18) and Holstein Friesian (1 out of 18). These findings were in disagreement with study conducted by Braun *et al*. (2007) [8] in which higher incidence found in Swiss braunveih (12 out of 28) followed by Simmental (10 out of 28) and Holstein Friesian (6 out of 28) could be due to variation in managemental practices and breed population in a respective geographical area. In this study higher incidence of thoracic foreign body was found in female (13 cases out of 18) as compared male (8 cases out of 18), Gouda *et al*., (2021) [13] also found occurrence of traumatic pericarditis in females (93%) than in male (7%). Gouda *et al.,* (2021) [13] stated that, the maximum number of females mainly affected in comparison to male due to load of pregnancy and parturition. In pregnancy weight of gravid uterus and during parturition labors create physical pressure on rumen and reticulum leading to perforation of sharp object to reach forward and penetrate the pericardium. Higher incidence of thoracic foreign body in age group ranges from 5-10 years (13 out of 18 cases) followed by 1-5 years (5 out of 18 cases). Total 18 animals with thoracic foreign body showed varied range of duration of illness ranged between 5-25 days. Out of 18, 4 cases showed 5-10 days duration of illness, eight animals showed 10-15 days, followed by 4 animals were suffering with 15-20 days illness and two animals had a 20-25 days illness history. In present study higher incidence of thoracic foreign body noticed in early lactation (8 cases out of 18. Similar observations noted by Kumar *et al.* (2012) found 10 bovine (3 cow and 7 buffalo) were recently parturiated and in early lactation. Most of animals affected with thoracic foreign body reported in winter season (9 out of 18) followed by monsoon (6 out of 18) and least in summer (1 out of 18). The present observations were in concurrence with Hajigharmani and Ghane (2010) in which they recorded that, the incidence of traumatic reticuloperitonitis (TRP) and traumatic pericarditis (TP) was found higher in winter season could be, most the animals were kept in stall feeding (chopped fodder and silage) and most of the animals were sheltered or stabled (Radostits *et al.* 2007) [21]. Higher incidence of

thoracic foreign bodies found in right hemithorax (7 out of 18), followed by center of hemithorax and 5 animals manifested in left hemithorax. Present study observations are in disagreement with Hussain *et al.,* (2018) [14] found higher number of cases 65% in left hemithorax.

Physical and clinical findings

Majority of the animals exhibited anorexia (83.33%), jugular pulsation (66.66%), brisket edema (66.66%), emaciation (91.66%), majority (58.33%) of the animals showed muffled heart sound indicative of pericarditis and absence of ruminal motility/stasis. The mean average values of heart beat, respiration rate and rectal temperature were 101.91±2.95 beats/min, 35.91±1.28/min and 103.5±0.30 °F respectively, showed increasing trend, indicative of significant changes in the physiological parameters in all animals. Similarly, Braun *et al.* (2007) [8] noticed increase in vital parameters like heart rate, respiration rate, rectal temperature and absence of ruminal motility in cattle affected by traumatic pericarditis. In present study animals suffering with thoracic foreign bodies which were in the lactating stage showed drastic reduction in milk yield and reluctance to move could be due to persistent pain in thoracic cavity elicited by foreign bodies. Similar findings were reported by Ghanem (2010) [12]. Five animals (40%) were showed highly impacted rumen indicative of ruminal stasis and absence of motility.

In present study, the mean average age of affected animals was 5.77±0.32 years; duration of illness was 12.36±0.69 days with span of 10-20 days is in accordance with the findings of Gouda *et al*. (2021) [13]. All the physiological parameters noted before during and after 48 hrs of surgery, All parameters elevated pre-surgically and significantly reduced during surgery due to effect of anaesthesia as indicated in Table no. 1

Haematological findings

Among the haematological findings mean value of haemoglobin recorded on lowest range (8.49±0.24g/dl) given in Table no. 2. Similar findings noted by Ghanem (2010) [12] in cattle suffering from traumatic pericarditis. The loss of blood during the entry of foreign bodies or the persistent inflammatory process causes the decreased haemoglobin value in cows with foreign body syndrome (Ocal *et al.* 2008) [20]. Reduced total erythrocyte count noted in cattle (7.05±0.33×10^6/µl). Lakhpati *et al.,* (2019) [16] also noticed reduced value of total erythrocyte count in cattle suffering with foreign body syndrome. In present study granulocytosis (6.48±0.51×10^6/µl) is consistent finding. Aref *et al*. (2013) [4] observed granulocytosis in animals affected with foreign body syndrome. Lymphopenia observed in present study (4.77±0.33×10^6/µl). Similar observations noted by Ghanem (2010) [12] in cattle suffering from TP and TRP. They stated that lymphopenia in foreign body cases may be due to low level of cellular immunity and stress of penetration of visceral organ by foreign body.

Radiographic findings

Lateral (right lateral as well as left lateral) abdominal radiographic positioning was found to be excellent in all animals except in advanced pregnant animal due to heavy abdominal shape this observation is in agreement with Makhdoomi *et al.* (2018) [18]. Reticular delineation along with sand filled impression was noticed in most the cases whereas, in some cases non-penetration foreign body (leather ball) was located in reticulum (Fig 1; Fig 2). All animals showed presence of adhesion between reticulum to diaphragm and heart to diaphragm. The present radiographic findings were conferring with Singh *et al*. (2007) and Aref and Abdel Hakiem (2013) [4] (Fig 3-A and Fig 3-B).

In this study, another classical radiographic finding in all animals showed loss of diaphragmatic contour (80%) which separates the thoracic cavity from abdominal cavity indicative of formation of adhesion between reticulum-diaphragm and thoracic organs due to chronic inflammation created by piercing of foreign body into thoracic cavity, all animals showed loss of cardiac silhouette due to chronic pericarditis. Similar findings reported by Sheikh *et al.* (2011) in cattle suffering from pericarditis (Fig 4-A ; Fig 4-B).

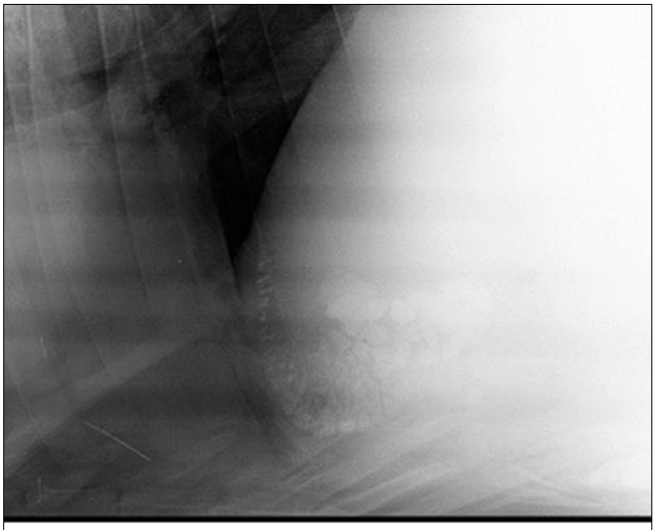

Fig 1: Presence of sand particle in reticulum

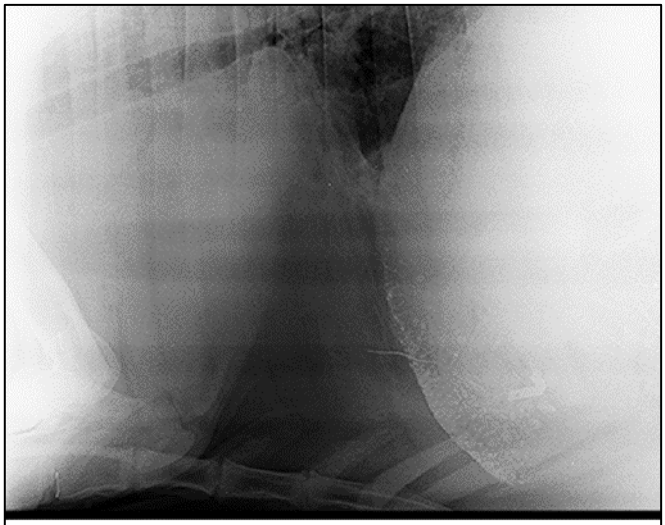

Fig 2: Presence of leather ball in reticulum

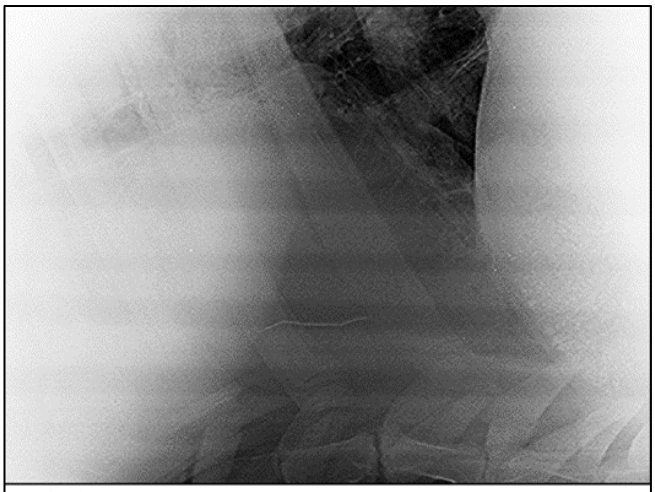

Fig 3-A: Presence of cardio phrenic and reticulophrenic adhesions characterized by cloudy and glassy appearance on radiographs

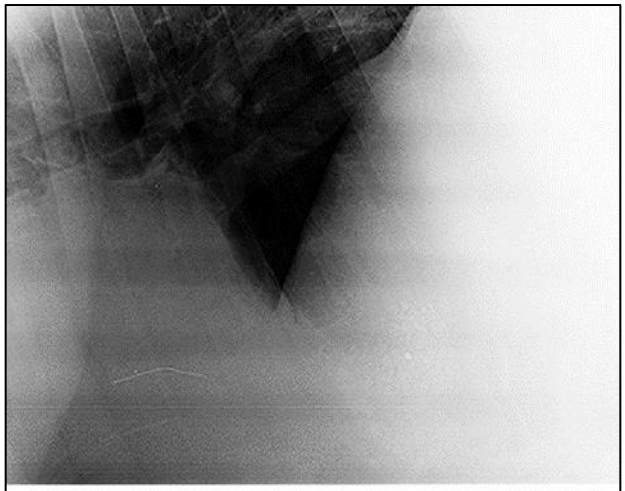

Fig 3-B: Presence of cardio phrenic and reticulophrenic adhesions characterized by cloudy and glassy appearance on radiographs

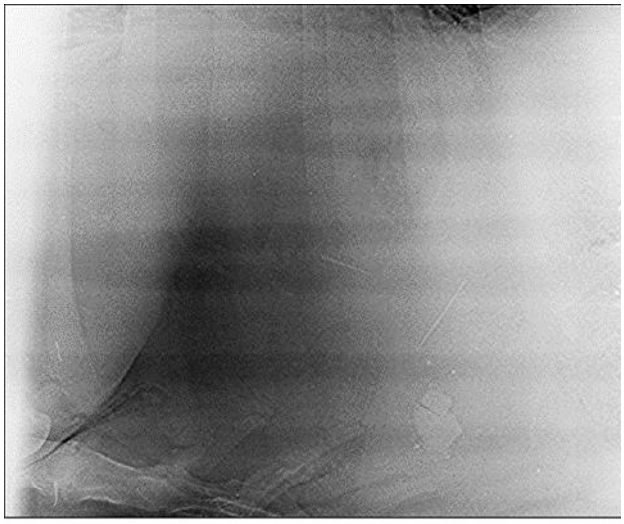

Fig 4-A: Loss of cardiac silhouette and diaphragmatic contour

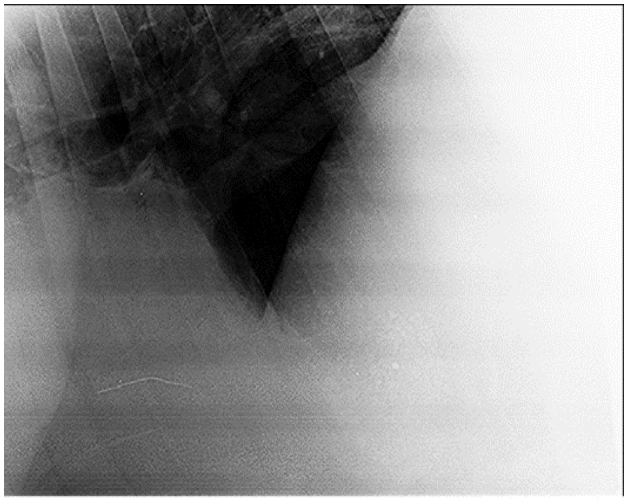

Fig 4-B: Loss of cardiac silhouette and diaphragmatic contour

Out of 12, three cases showed diaphragmatic hernia with presence of radiopaque metallic foreign body in reticular pouch in thoracic cavity. Similar findings noted by Singh *et al*. (1996), Misk and Semieka (2001), Athar *et al*. (2010) [5] and Suryawanshi *et al*. (2022) [25] (Fig 5-A; Fig 5-B).

Radiological evaluation of potential thoracic foreign body

In present study, all animals underwent for right as well as left lateral thoraco-abdominal radiography to rule out the exact location of foreign bodies. During the radiography, Source-Image-Distance (SID) and magnification concept was kept in the mind. Singh (1994) [23] stated that, if an object placed in the path of light source, shadow is formed. As the object is brought nearer to source of light, the shadow enlarges and vice and versa. In other words, shorter the distance the between object and light source, the magnification of image supposed to be greater/higher. The length of thoracic foreign body in right lateral and left lateral recumbency is measured by using computerised radiography system and on the basis of magnification; the location of foreign body in right or left hemithorax was recorded e.g. case stated at sr. no. 1 foreign body measuring 6.62 cm long in right lateral recumbency and in same animal length of foreign body was 7.8 cm long in left lateral recumbency hence the prediction of presence of location of foreign body was in right hemithorax as per statement of Singh (1994) [23] on the basis of magnification. In present study 5 animals (41.66%) showed presence of thoracic foreign bodies in right hemithorax (Fig 6-A and Fig 6-B) followed by 4 animals (33.33%) showed central hemithorax (Plate 7) and 3 cases (25%) exhibited left hemithorax foreign bodies (Fig 8). In contrast, Hussain *et al*. (2018) [14] reported that, 65% cases of traumatic pericarditis showed presence of foreign bodies in left hemithorax in cattle. (Table no.3)

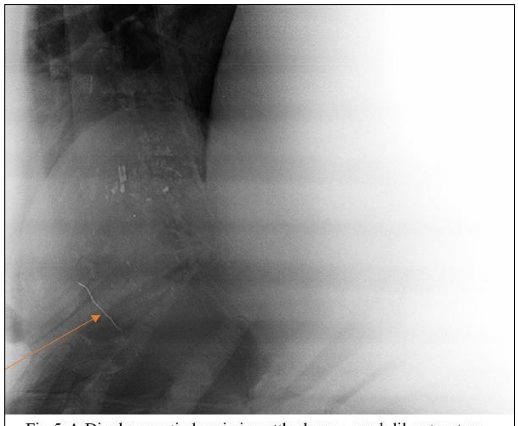

Fig 5-A:Diaphragmatic hernia in cattle, honey comb like structure present in thoracic cavity with radiopaque metallic foreign bodies

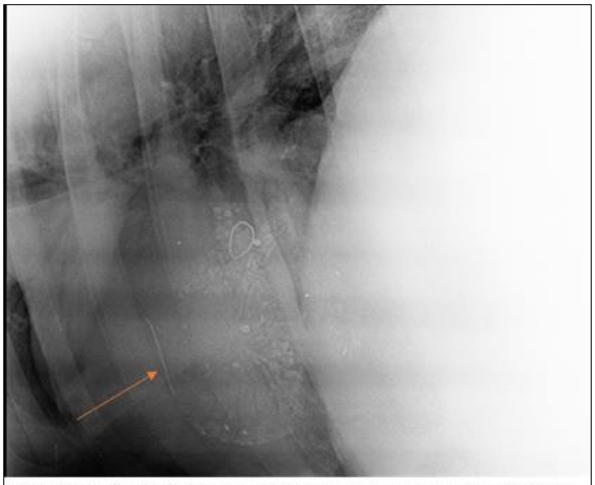

Fig 5-B: Diaphragmatic hernia in cattle, honey comb like structure present in thoracic cavity with radiopaque metallic foreign bodies

Anaesthetic observations

All animals underwent thoracotomy were sedated with Inj. Diazepam @ 0.25mg/kg intravenously characterized by ataxia, drowsiness, in coordination in gait and they assumed lateral recumbency on operation table, similar observations noted by Abrahamsen (2008). Out of 12, 6 animals received induction of anaesthesia with inj. Propofol @3mg/kg intravenously till effect. Remaining 6 animals were induced with ruminant double drip and was administered @ 1.5mL/kg body weight. There were no adverse effects like breath holding, cyanosis, and seizures. The muscle relaxation was adequate for passing the endotracheal tube in all animals as stated by Dhawale *et al*., (2019) [9] and Kherkar *et al*., (2019) [15].

General anaesthesia was maintained with help of 2 % isoflurane gaseous anaesthesia in all animals. It provides good muscle relaxation and complete loss of Palpebral, corneal and swallowing reflexes with good depth of anesthesia for 128-140 minutes. Similar findings noted by Kherkar *et al*., (2019) [15]. The isoflurane was showed smooth and uneventful recovery in all animals indicative of limited effects on cardiovascular and pulmonary system.

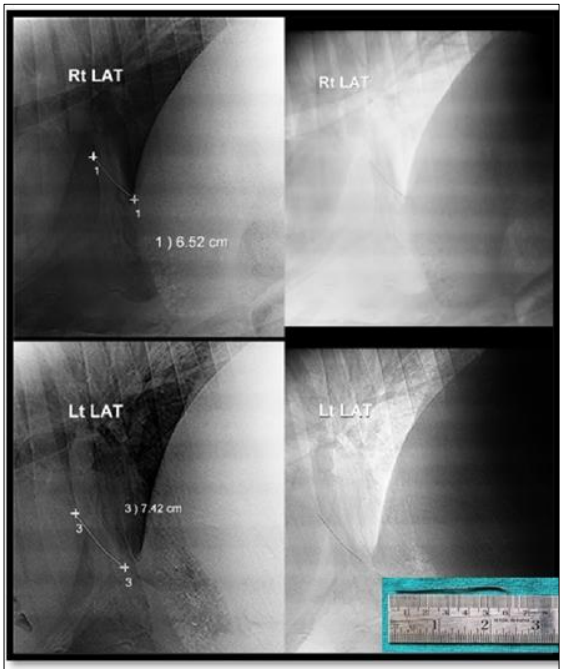

Fig 6-A: Length of thoracic foreign body was smaller in right lateral recumbency (6.52 cm) compare to left lateral recumbency (7.42 cm) indicating prognostic presence of foreign body in right hemithorax. Same radiograph was viewed via contrast. (Actual length of foreign body 6.1 cm depicted in Inset).

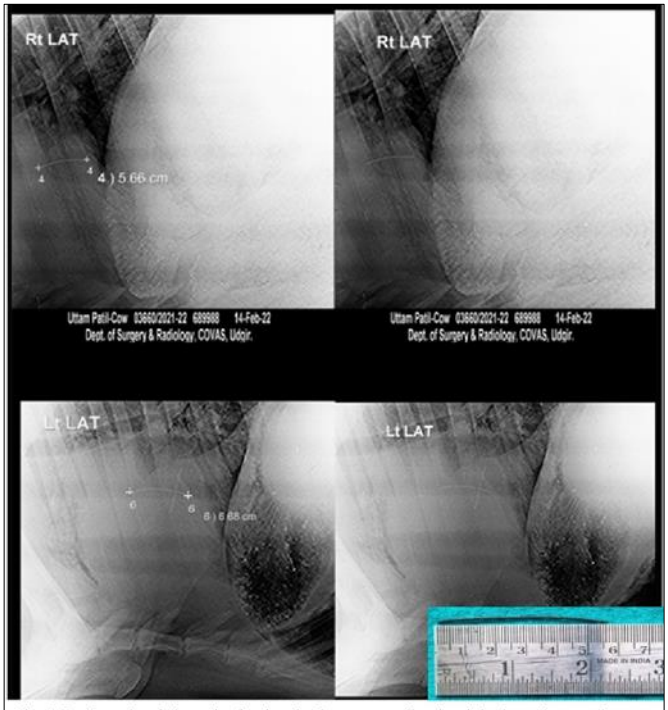

Fig 6-B: Length of thoracic foreign body was smaller in right lateral recumbency (5.66 cm) compare to left lateral recumbency length (6.68 cm) indicating prognostic presence of foreign body in right hemithorax. (Same radiograph viewed via contrast. Actual length of foreign body 5.60 cm depicted in Inset).

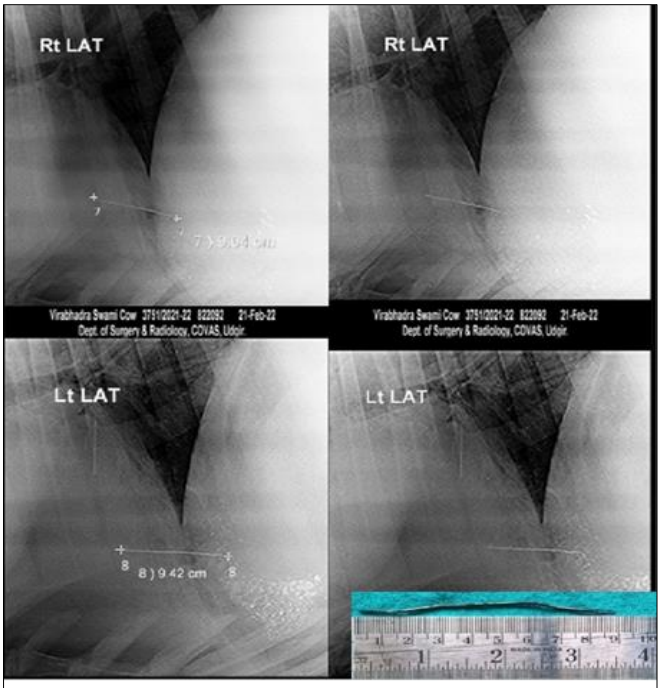

Fig 7: Non significant difference present in length of thoracic foreign body in right lateral recumbency (9.04 cm) and in left lateral recumbency (9.42 cm) indicating prognostic presence of foreign body in centre of thorax. (Same radiograph viewed via contrast. Actual length of foreign body 9.00 cm depicted in Inset).

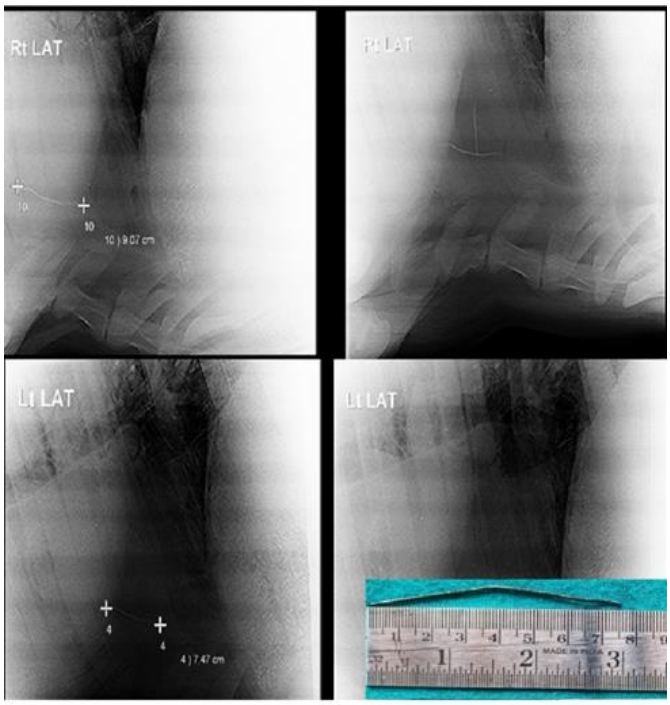

Fig 8: Length of thoracic foreign body was larger right lateral recumbency (9.07 cm) compare to left lateral recumbency (7.47 cm) indicating prognostic presence of foreign body in left hemithorax. Same radiograph viewed via contrast. (Actual length of foreign body 7.50 cm depicted in Inset.

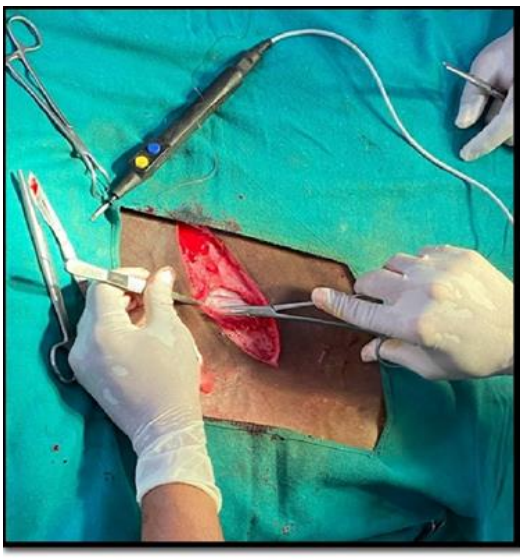

Fig 9: Incision on rib

Fig 10: Disarticulation of rib from costochondral junction

Fig 11: Maintenance of animal on Intermittent positive pressure ventilation

Fig 12: Removal of potential foreign body from thorax

Surgical Procedure

In all the animal's rumenotomy performed prior to thoracotomy. In majority of cases rumen impacted with presence of non-penetrating foreign bodies (plastic, leather ball and ropes) with reticulo-diagrammatic adhesions was prominently observed. In some cases, there was fibrinous band indicative foreign bodies track was palpable. Similar observations noted by (Simieka 2010). In three cases, thoracic foreign bodies were removed through diaphragmatic hernial ring and herniorrhaphy was performed by post xiphoid incision under inhalation anaesthesia. All animals were recovered uneventfully after rumenotomy, thoracotomy and diaphragmatic herniorrhaphy. Out of 12, 9 animals underwent thoracotomy for removal of foreign bodies via complete rib resection technique. Incision given directly over rib to be resected (Fig. 9 and Fig. 10) under Intermittent Positive Pressure Ventilation (IPPV) (Fig 11) (Ducharme *et al.* 1992 and Londhe *et al.* 2021) [17] it was found to be more adequous technique for handling of thoracic organ and removed foreign bodies successfully as per predicted location of foreign body in the hemithorax (Fig. 12). Radiographic location of foreign bodies in all cases is found exactly in same hemithorax as prognostic location determined as per magnification on computerized radiography. None of animals showed post thoracotomy complication like seroma formation or respiratory distress.

Table 1: Mean average (Mean±SE) values of Physiological parameters of cattle suffering from thoracic foreign body (n=12)

Sr No.	Parameter	Affected			F value
		Before	During	After	
1.	Heart rate (beats/min)	101.91±2.95^{b}	69.16±3.54^{a}	79.67±2.57^{a}	30.09**
2.	Rectal temperature (°F)	103.70±0.30^{b}	99.08±0.20^{a}	101.93±0.20^{b}	73.45**

(** Highly Significant p=<0.01; means bearing different superscripts differ significantly from each other)

Table 2: Haematological finding of cattle suffering from thoracic foreign body(n=12)

Sr no.	Parameters	SI unit	Affected			F value
			Before	During	After	
1	TEC	$\times10^{6}$/µl	7.05±0.33	6.95±0.33	7.13±0.31	0.79^{NS}
2	Hb	g/dl	8.49±0.24	8.39±0.23	8.78±0.26	0.67^{NS}
3	PCV	%	27.60±0.82	26.96±0.62	28.36±0.94	0.47^{NS}
4	TLC	$\times10^{3}$/µl	12.04±0.86	11.77±0.83	11.52±0.90	0.91^{NS}
5	LYM	$\times10^{6}$/µl	4.77±0.33	4.65±0.32	5.03±0.33	0.35^{NS}
6	GRA	$\times10^{6}$/µl	6.48±0.51	6.34±0.51	5.96±0.56	0.26^{NS}

NS-Non-Significant

Table 3: Prediction chart of radiographic evaluation of foreign body in thorax

Sr No.	Length of foreign body in thoracic cavity in cm (n=12)		Magnification	Prognostic presence of foreign body
	Right recumbency	Left recumbency		
1.	6.62	7.8	Left hemithorax	Right hemithorax
2.	5.66	6.68	Left hemithorax	Right hemithorax
3.	9.04	9.42	No major difference	Centre
4.	6.52	7.42	Left hemithorax	Right hemithorax
5.	3.67	4.21	No major difference	Centre
6.	7.30	7.80	No major difference	Centre
7.	9.07	7.47	Right hemithorax	Left hemithorax
8.	9.6	8.80	Right hemithorax	Left hemithorax
9.	5.4	5.8	No major difference	Centre
10.	6.23	6.75	Left hemithorax	Right hemithorax
11.	6.59	7.41	Left hemithorax	Right hemithorax
12.	5.30	6.30	Left hemithorax	Left hemithorax

Table 4: Surgical removal of prognostic foreign body from thoracic cavity

Sr no	Length of foreign body in thoracic cavity in cm (n=12)		Prognostic position of foreign body in hemithorax	Site of surgery	Actual length of foreign body in cm observed after surgery and depicted in(Insat) Fig 6A & 6B, Fig-7 and Fig-8
	Right hemithorax	Left hemithorax			
1.	6.62	7.8	Right hemithorax	5th rib resection on right hemithorax	6.61
2.	5.66	6.68	Right hemithorax	5th rib resection on right hemithorax	5.60
3.	9.04	9.42	Centre	6th rib resection on right hemithorax	9.00
4.	6.52	7.42	Right hemithorax	4th rib resection on right hemithorax	6.10
5.	3.67	4.21	Centre	Post xiphoid diaphragmatic herniorhaphy	3.60
6.	7.30	7.80	Centre	6th rib resection on right hemithorax	7.33
7.	9.07	7.47	Left hemithorax	5th rib resection on left hemithorax	7.50
8.	9.6	8.80	Left hemithorax	6th rib resection on left hemithorax	8.80
9.	5.4	5.8	Centre	Post xiphoid diaphrgmatic herniorhaphy	5.36
10.	6.23	6.75	Right hemithorax	Post xiphoid diaphrgmatic herniorhaphy	6.10
11.	6.59	7.41	Right hemithorax	5th rib resection on right hemithorax	6.50
12.	6.30	5.30	Left hemithorax	6th rib resection on left hemithorax	6.30

Conclusion

The present clinical study was concluded that, the exact location (right or left hemithorax) of thoracic metallic foreign body was diagnosed via SID and magnification hypothesis revealed that, shorter the distance between object and light source, the magnification of image (foreign body) supposed to be greater which helps in detecting exact location of foreign bodies. It was also summerised that, radiographic length of thoracic potential foreign body was nearer to retrived foreign body via thoracotomy in all animals which helps for selection of most site of thoracotomy procedures in large animal practice.

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